

An OLR perspective on La Nina and El Nino seasonal weather impacts over North America

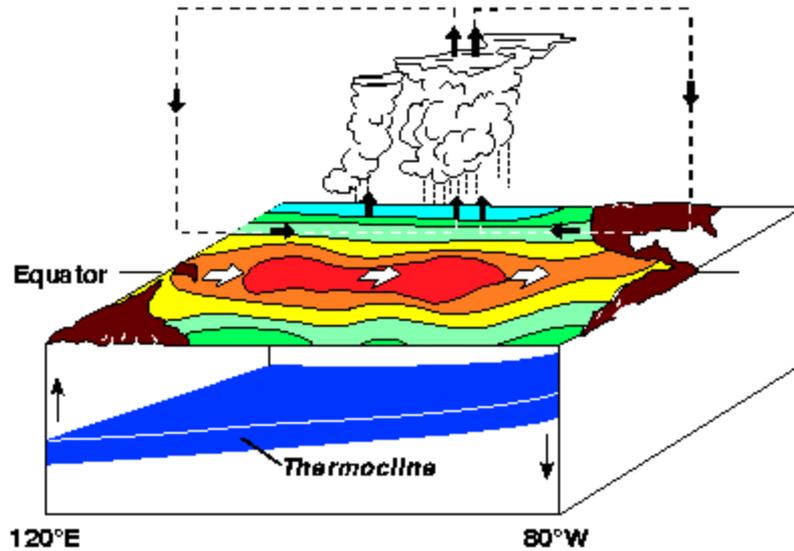
Andy Chiodi & Ed Harrison

Univ. of WA (JISAO) and NOAA/PMEL

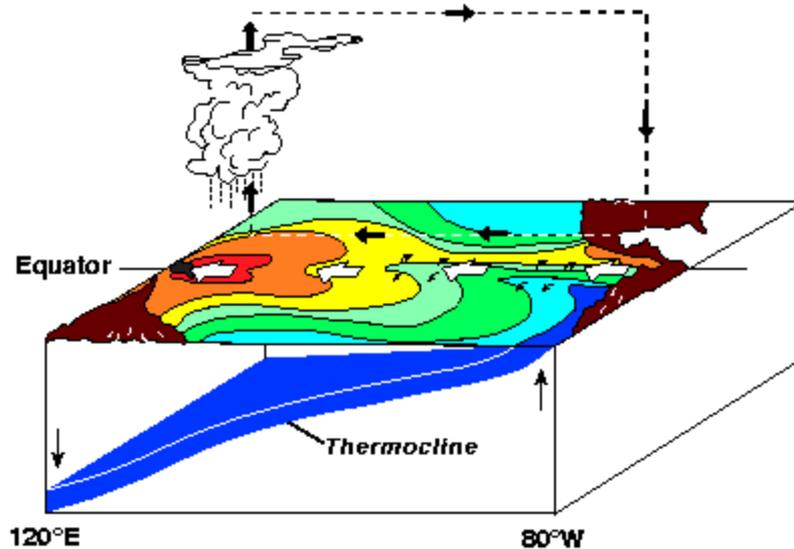
An Outgoing-Longwave-Radiation (OLR) Perspective on ENSO impacts

- SLP, SST and OLR all provide measures of coupled-system anomalies during ENSO, but OLR provides best look at atmospheric heating anomalies which drive atmos. circulation, temp. and precip. anomalies elsewhere
- *Most of the statistically significant seasonal weather anomalies over North America result from a handful of events which can be identified by their OLR features*

El Niño Conditions



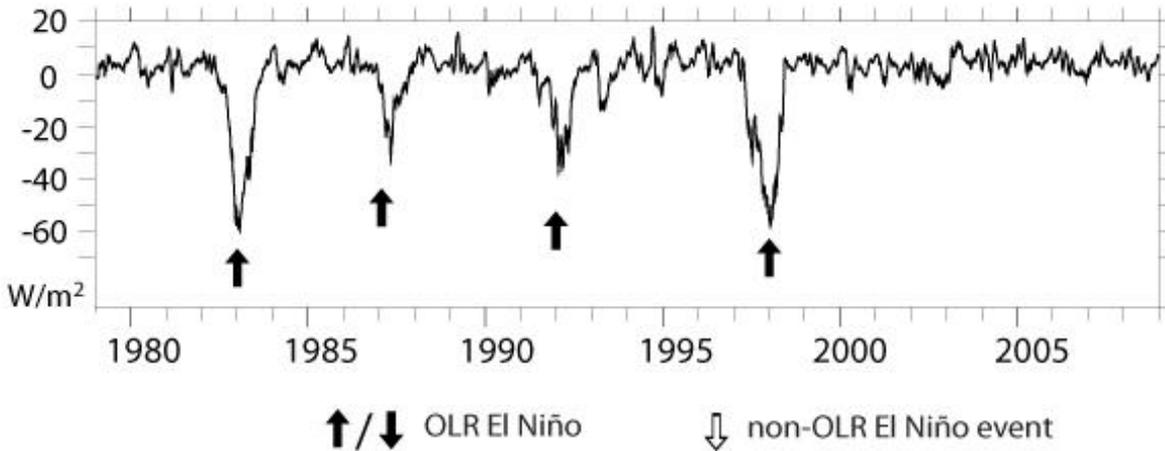
La Niña Conditions



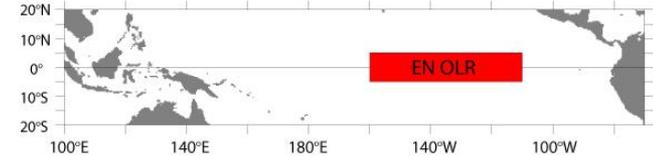
*OLR approach
motivated
initially by our
familiar ENSO
Cartoons*

Eastern Central Pacific OLR and El Niño

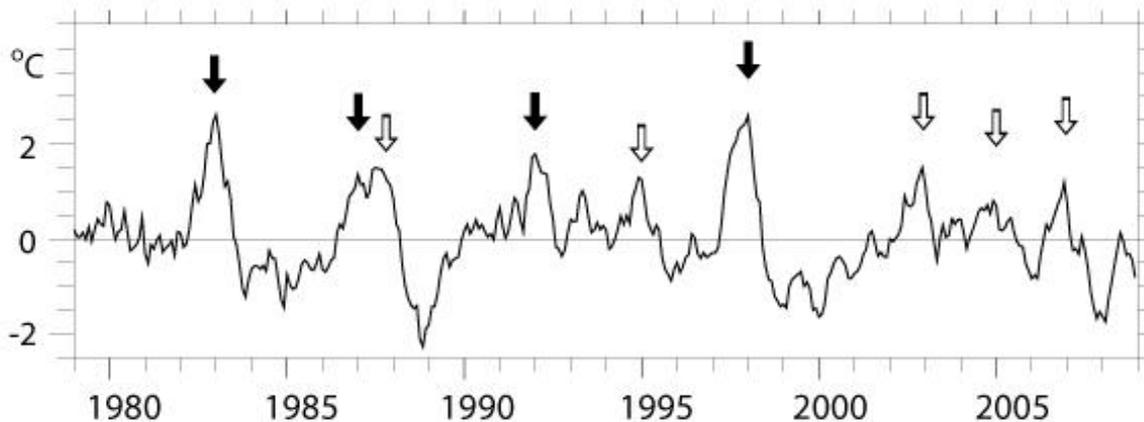
Eastern Central Pacific OLRA (160°W-110°W)



Monthly OLR Anom.
160°W:110°W and
5°S-5°N



Nino 3.4 SSTA



NINO3.4 SSTA

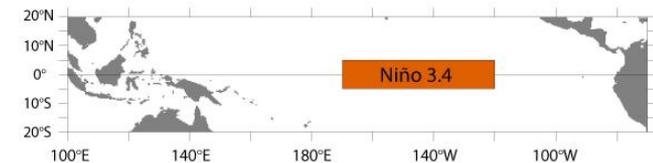
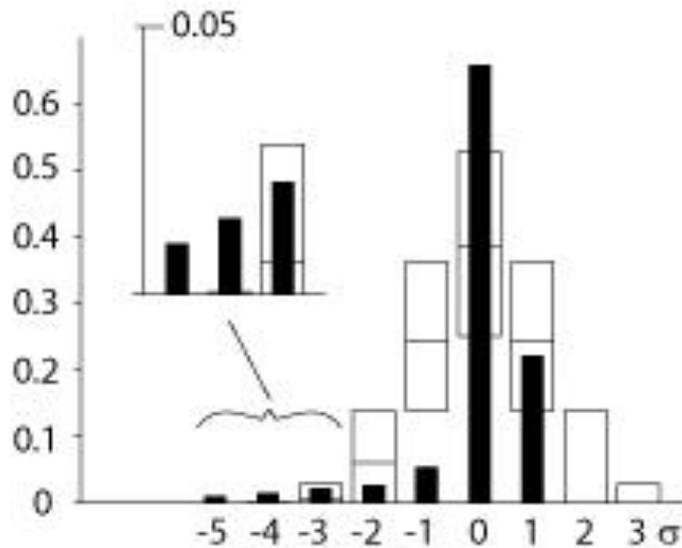


Figure from Chiodi and Harrison (*J. Climate*, 2013)

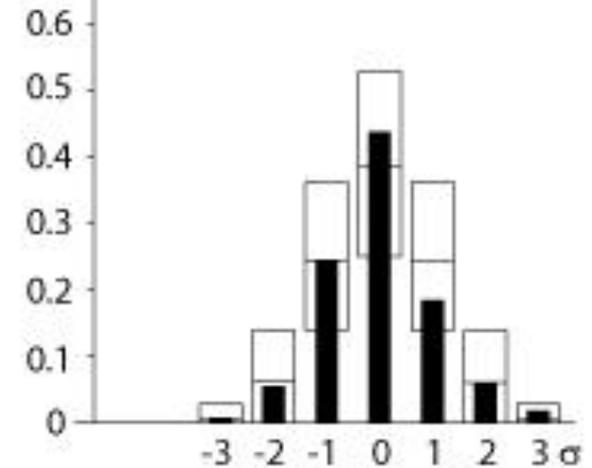
OLR from NOAA Interpolated data set (Liebmann and Smith, 1996)

OLR behavior is more event-like than SSTA, SLP

OLR El Niño Index



Niño 3.4



p=0.95
expected
p=0.05 } based on commensurate
Gaussian distribution

Only in the 4 large events does the index cross the -1.5σ boundary, and it does so before winter in 3 of 4 cases.

See Chiodi and Harrison (2010)

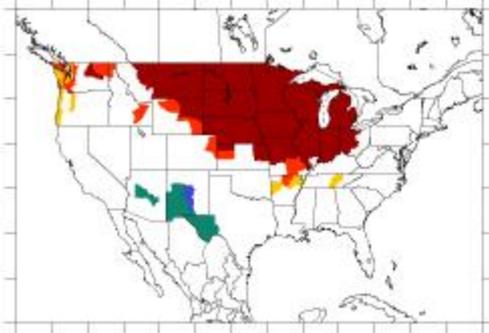
Seasonal Weather Associations

- The U.S. is one strongly affected region, but similar results are obtained elsewhere.
- Focus on wintertime, when N. American impacts are statistically strongest.
- The OLR events are typically identified by OLR behavior before winter in both **El Nino (3 of 4)** and **La Nina (6 of 6)** cases

USA Winter Surface Temp Anomaly for different subsets of El Nino events.

DJF Temperature

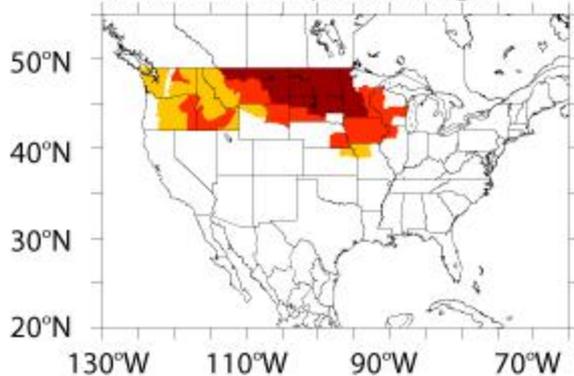
a) Four OLR Events



b) Five non-OLR Events



c) Nine Event Composite Average



Shading at 95% significance

OLR-El Nino
Event
Composite

Non-OLR El
Nino Event
Composite

All-Event
Composite

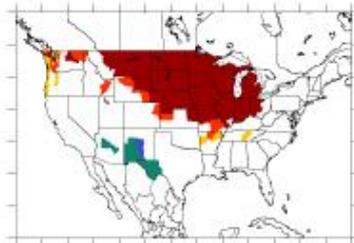
From Chiodi and Harrison (2013). Period 1979-2008.

Temp patterns are consistent among the OLR-EN years; different patterns seen in other years

DJF Temperature Anomalies

Composites

OLR El Niño



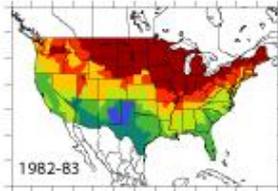
shading where significant ($p > 0.95$)

non-OLR El Niño

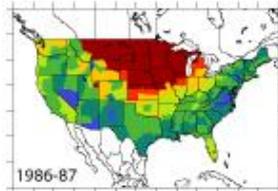


shading where significant ($p > 0.95$)

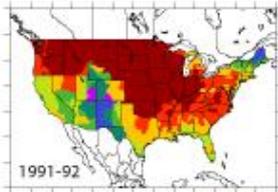
Individual years



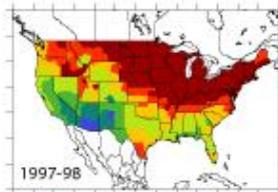
1982-83



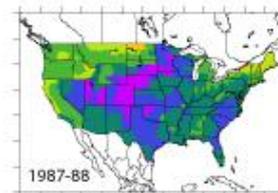
1986-87



1991-92



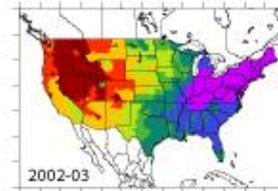
1997-98



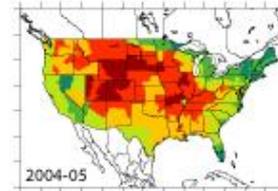
1987-88



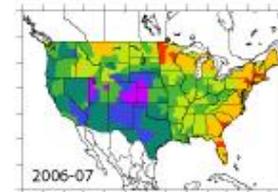
1994-95



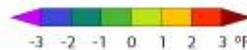
2002-03



2004-05



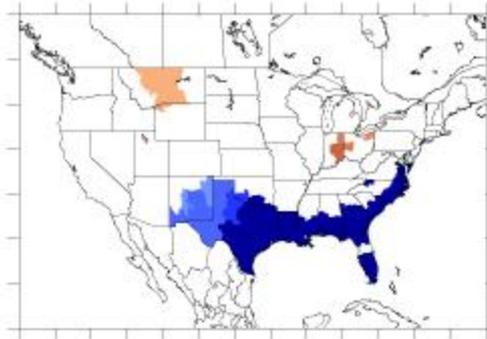
2006-07



As before, only for seasonal surface precipitation anomaly

DJF Precipitation

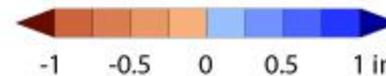
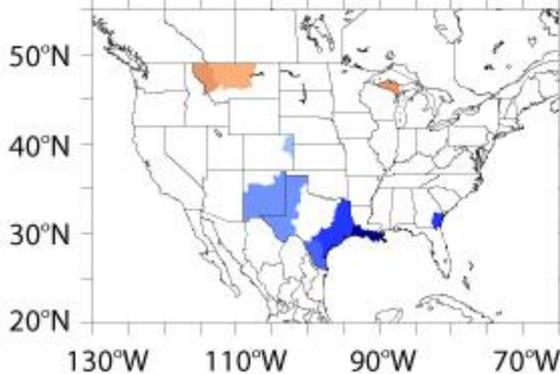
a) Four OLR Events



b) Five Dateline Events



c) Nine Event Composite Average



Shading at 95% significance

For OLR-El
Nino Events

For Non-OLR
El Nino
Events

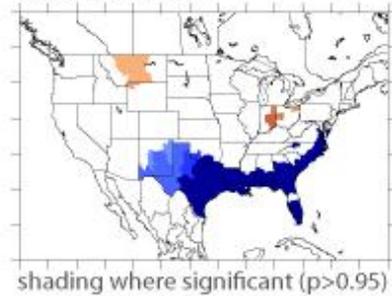
Including all
El Nino
Events

Again, as before, only for seasonal surface precipitation anomaly

DJF Precipitation Anomalies

Composites

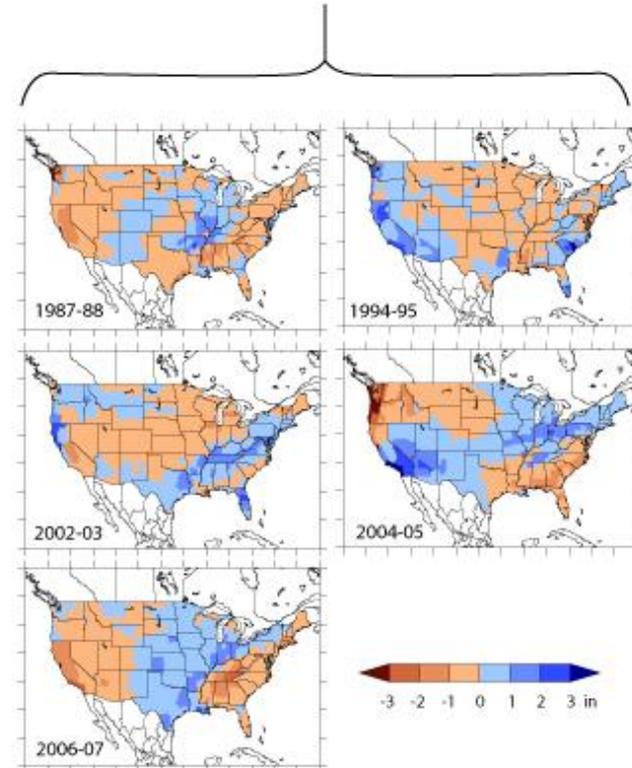
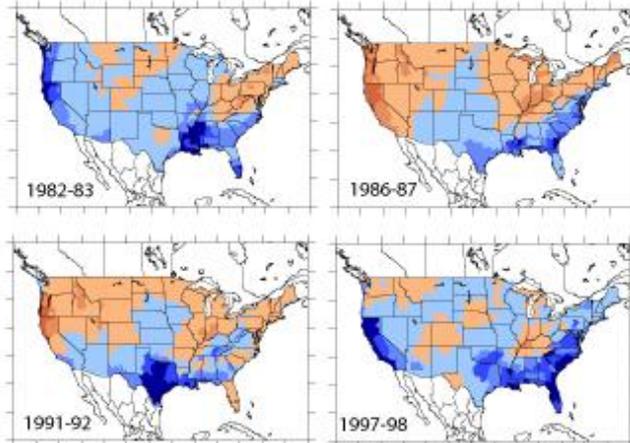
OLR El Niño



non-OLR El Niño



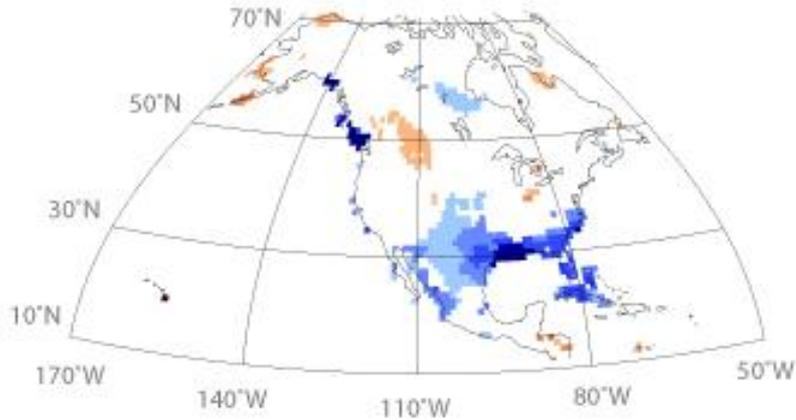
Individual years



Again, except for North America precip.

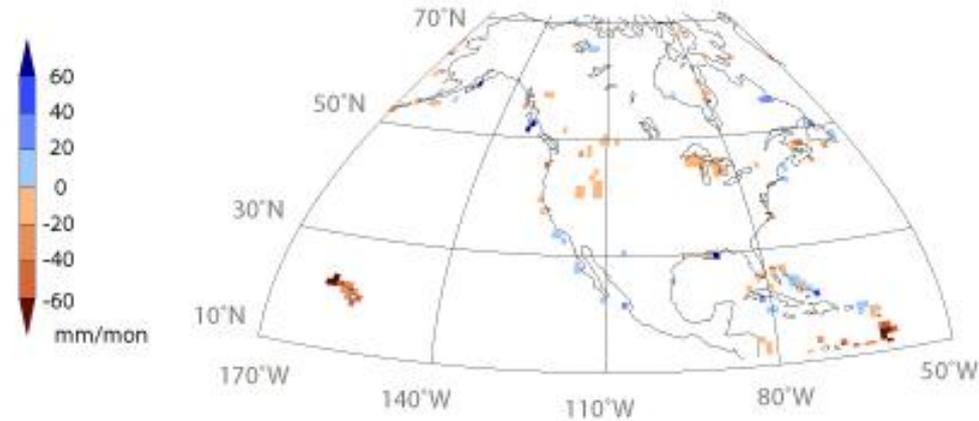
DJF Precipitation Anomalies

OLR El Niño



masking at 95% local statistical significance
period 1974-2011

non-OLR El Niño



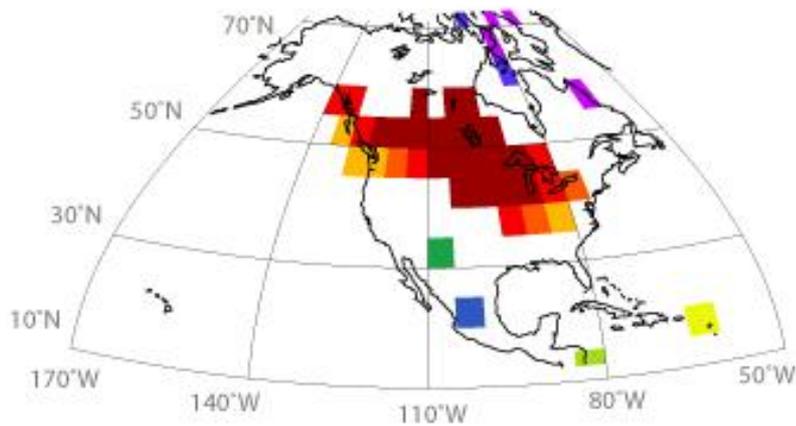
data: GPCP Global Precip

Masking at 95% local statistical significance

...and North America temp.

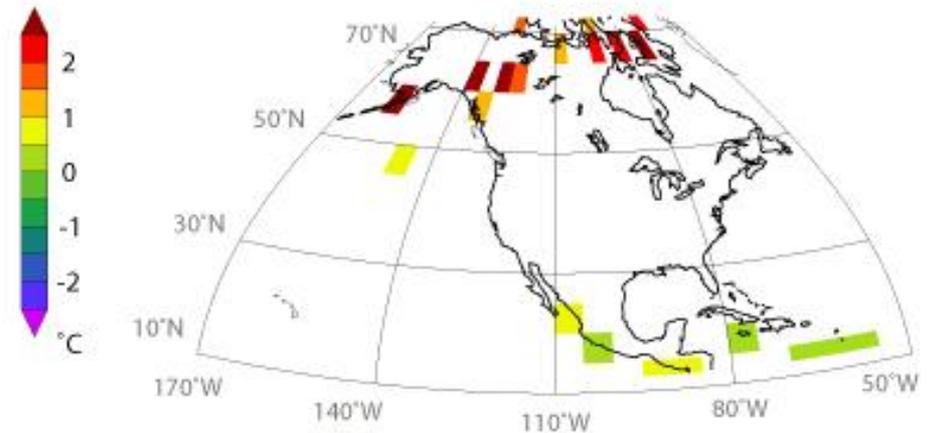
DJF Temperature Anomalies

OLR El Niño



masking at 95% local statistical significance
period 1974-2011

non-OLR El Niño



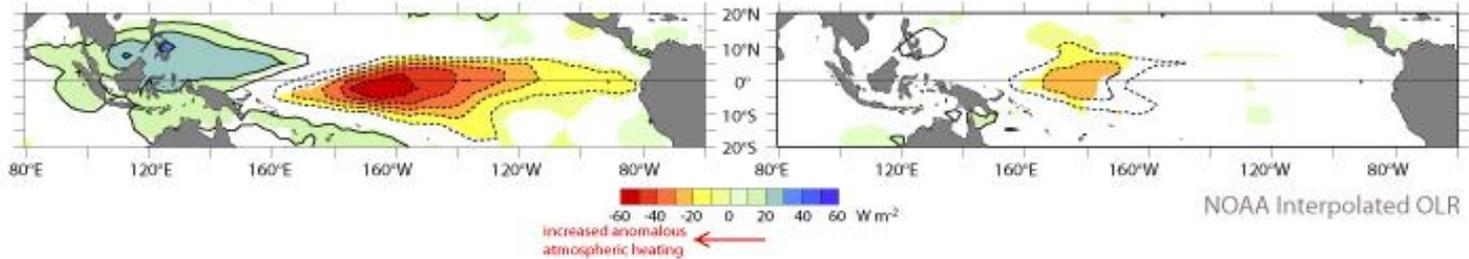
data: CRU Temp

Wintertime Anomaly Conditions

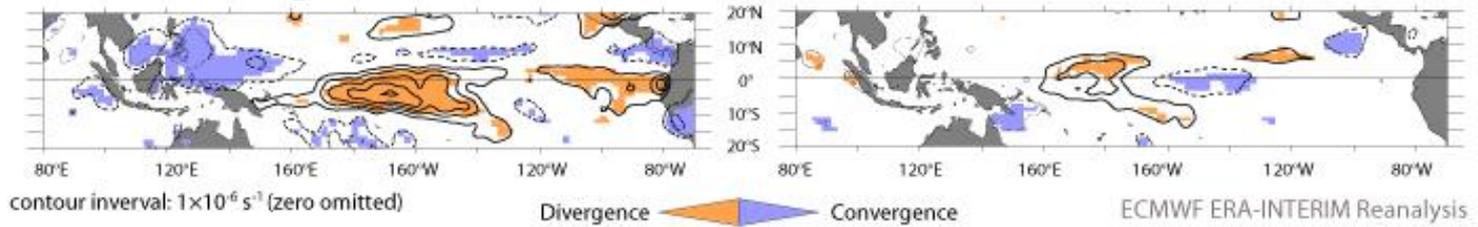
OLR-El Niño events

non-OLR events

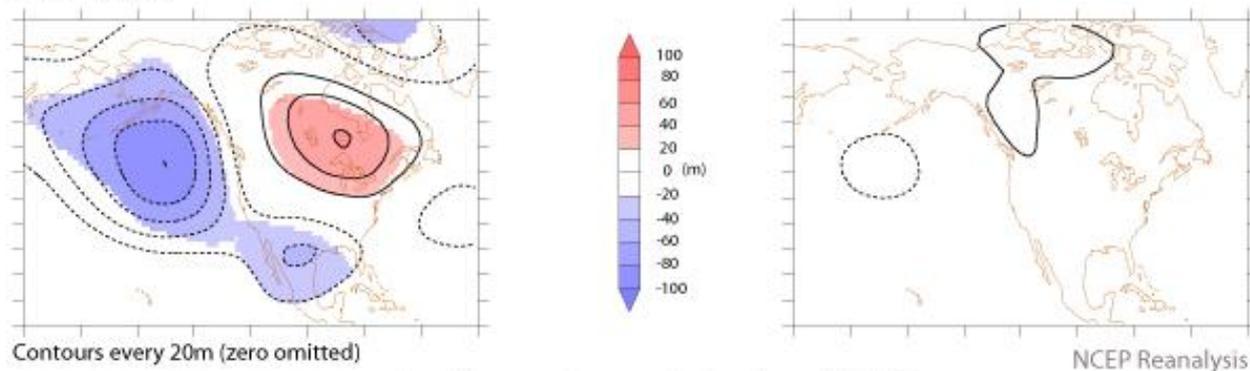
DJF OLR Anomaly



DJF 200 hPa Divergence



DJF z500'



shading where stat. sig. at 95%

Tropics

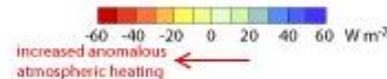
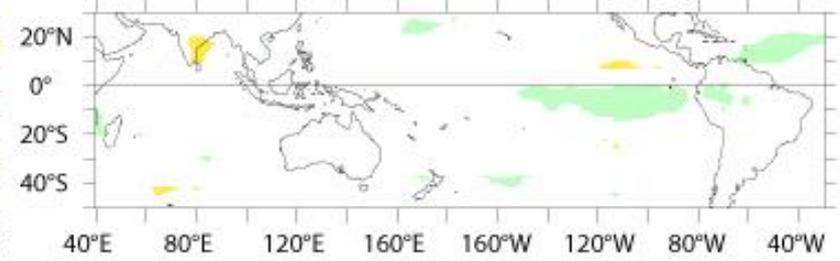
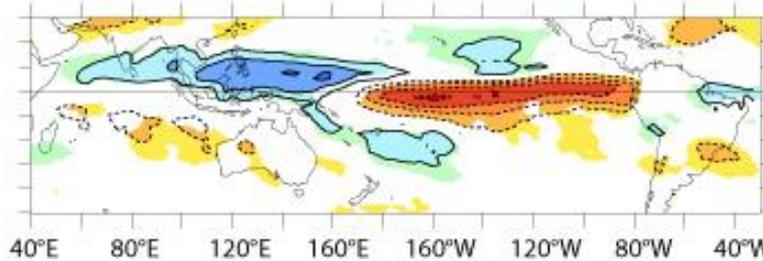
North America

Now for March-April-May,

OLR-EI Niño events

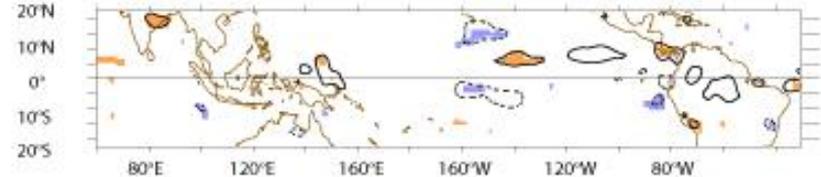
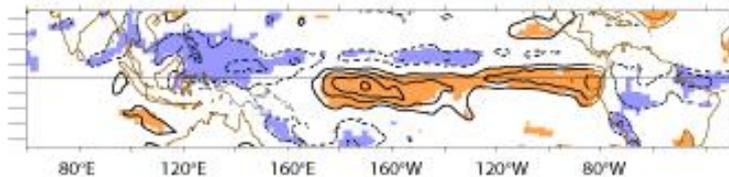
non-OLR events

MAM (Year 1) OLR Anomaly



NOAA Interpolated OLR

MAM 200 hPa Divergence



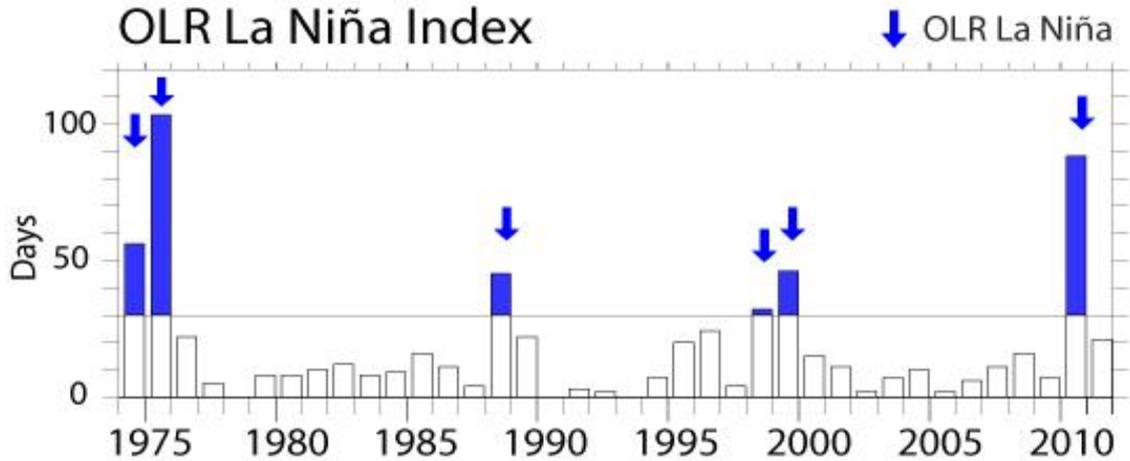
contour interval: $1 \times 10^{-6} \text{ s}^{-1}$ (zero omitted)



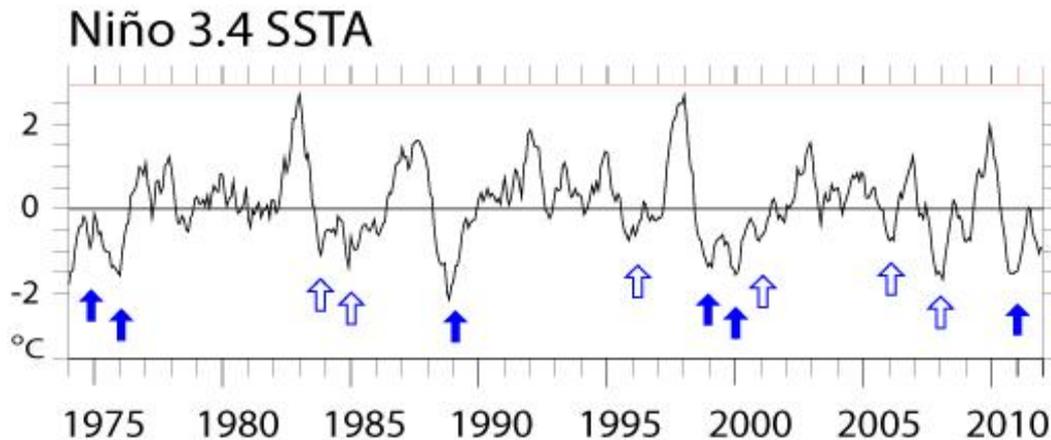
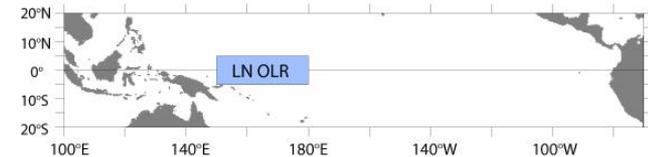
ECMWF ERA-INTERIM Reanalysis

shading where stat. sig. at 95%

An OLR index for La Niña

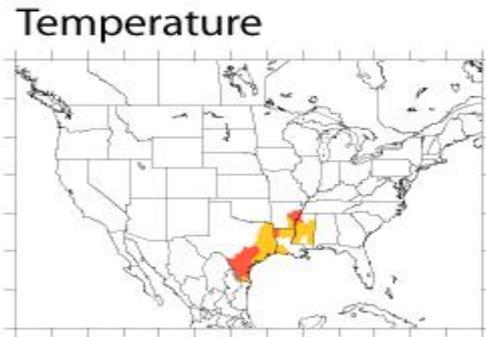


OLR-La Niña Index counts days of clear sky from 1 April to 31 Dec over 150E:180x5S:5N

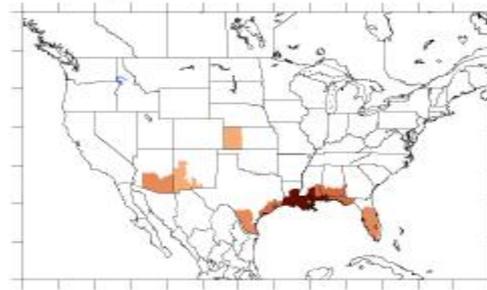


La Nina wintertime composite anomalies,

OLR La Niña
(6)



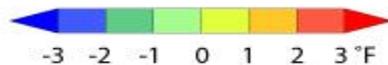
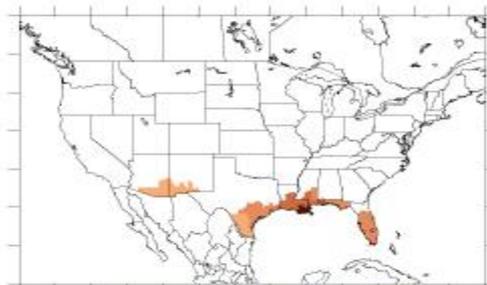
Precipitation



non-OLR
(6)



Combined
(12)



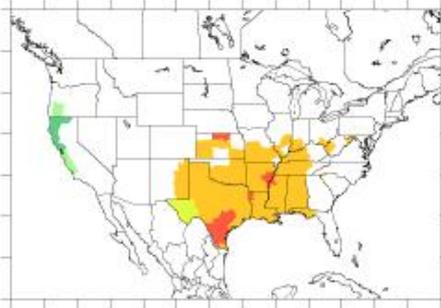
shading where significant ($p > 0.95$)

95% stat
sig

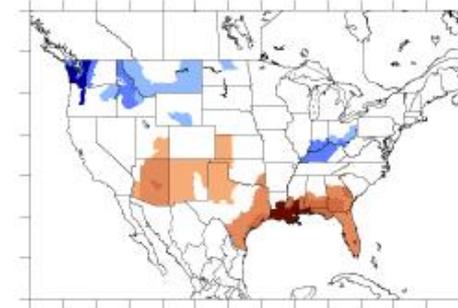
La Nina wintertime composite anomalies,

OLR La Niña
(6)

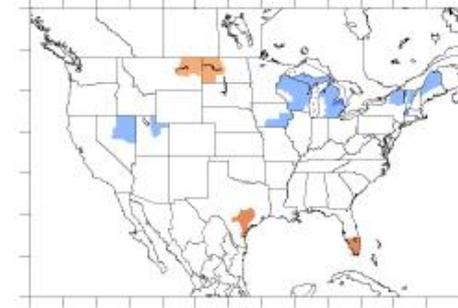
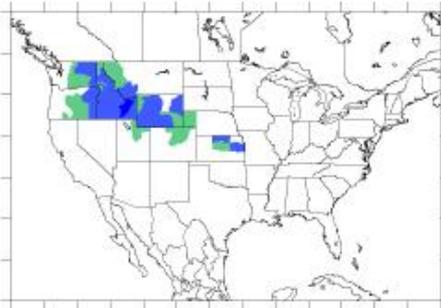
Temperature



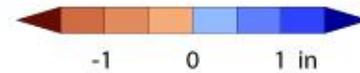
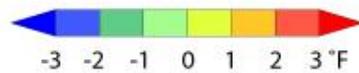
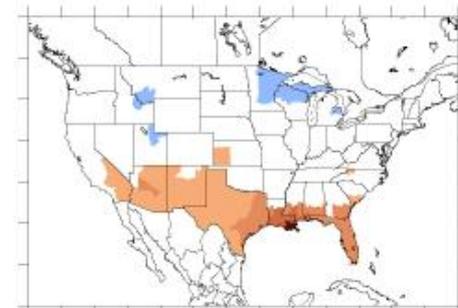
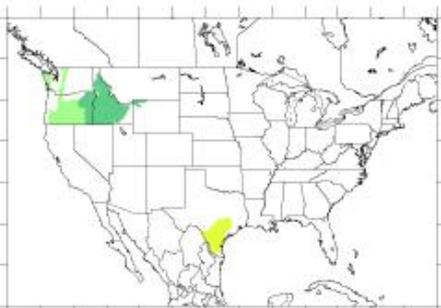
Precipitation



non-OLR
(6)



Combined
(12)



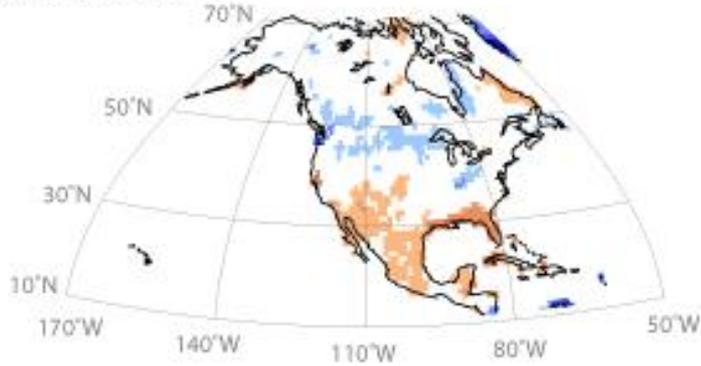
shading where significant ($p > 0.8$)

80% stat
sig

La Nina wintertime composite precipitation anomalies,

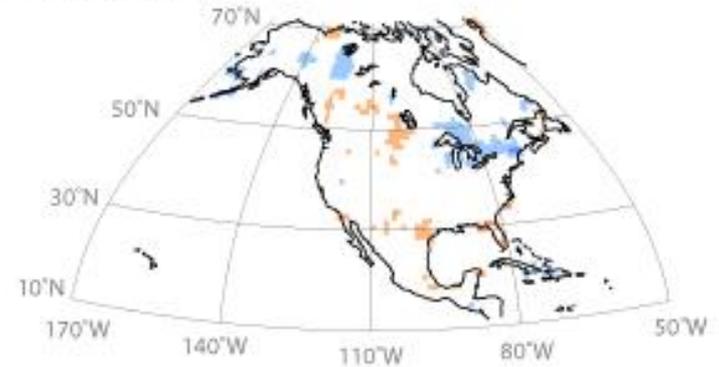
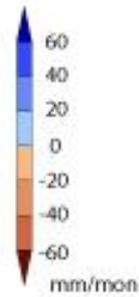
DJF Precipitation Anomalies

OLR La Niña



masking at 80% statistical significance
period 1974-2011

non-OLR La Niña



We find that trop. Pac. OLR behavior identifies the subset of commonly considered ENSO events that most strongly account for the familiar winter seasonal atmos. circulation, temp. and precip. anomalies over the US.

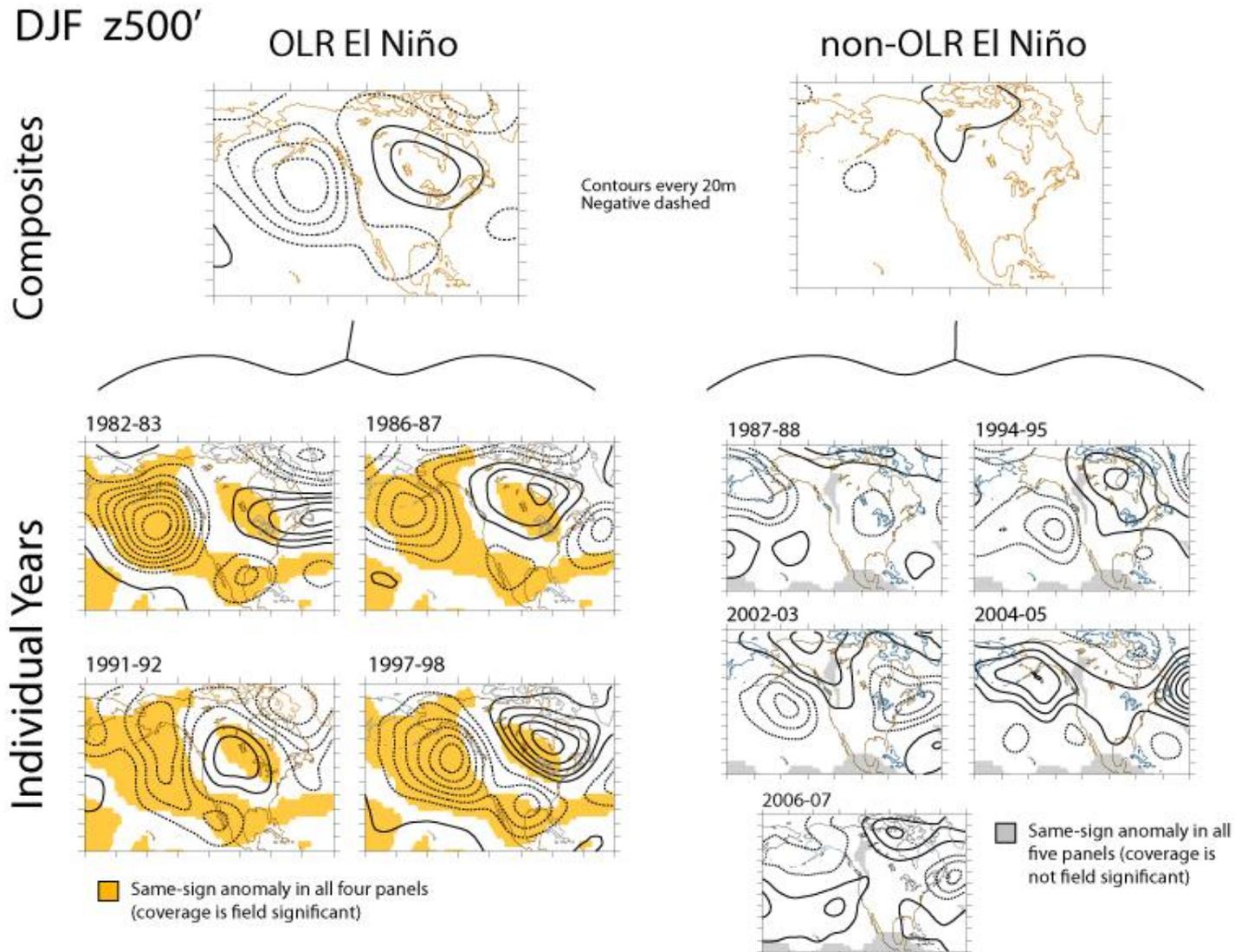
OLR events are typically identified in time to be of use to wintertime forecasting efforts (long ENSO life-cycle)

There is no simple mapping from NINO3.4 SSTA to OLR

There is little high statistical significance weather anomalies associated with the non-OLR events.

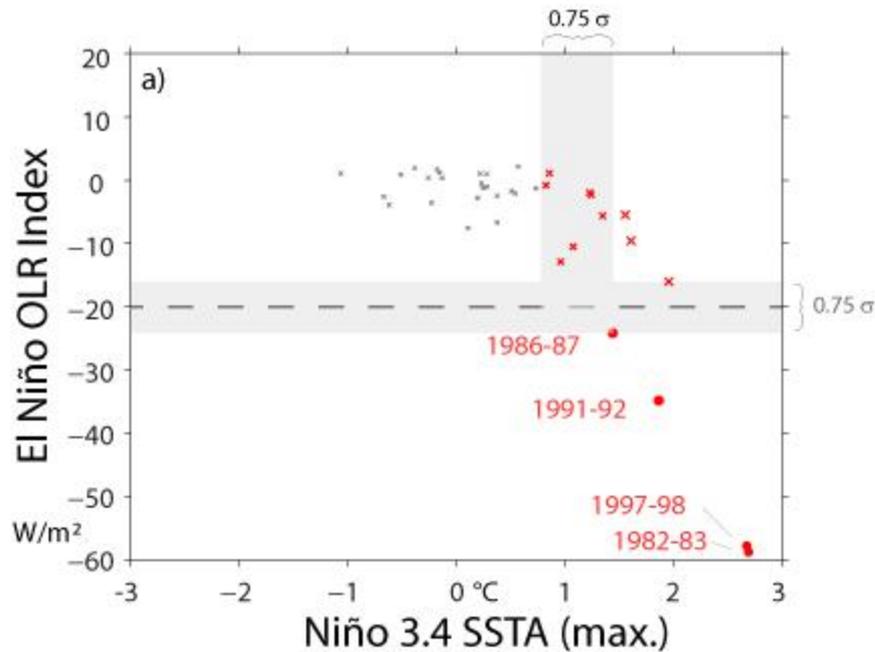
This suggests that paying more attention to the OLR behavior of the tropical Pacific, in both models and statistical forecasting efforts, may result in higher-confidence seasonal weather predictions.

Z500' patterns are similar among the individual OLR years; different otherwise

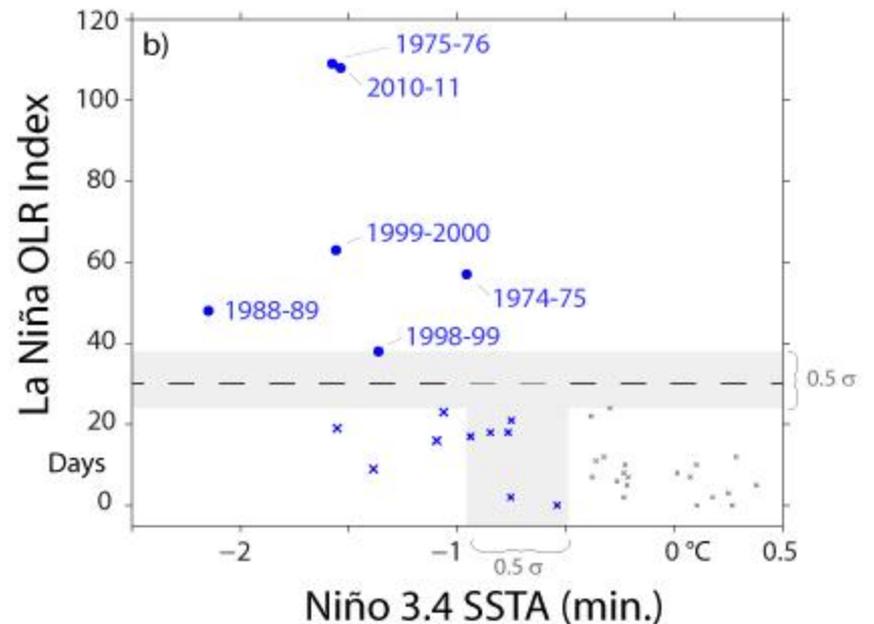


Interannual OLR and SSTA Peaks

El Niño

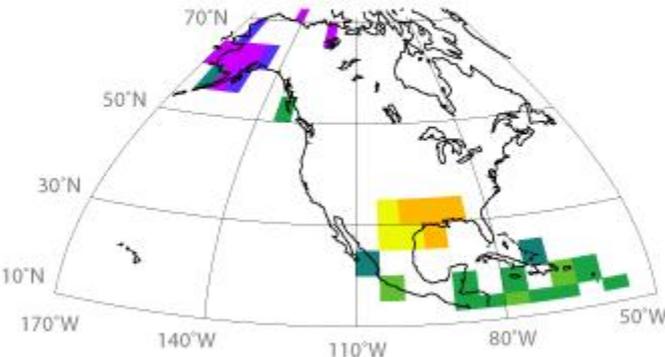


La Niña



DJF Temperature Anomalies

OLR La Niña



masking at 95% local statistical significance
period 1974-2011

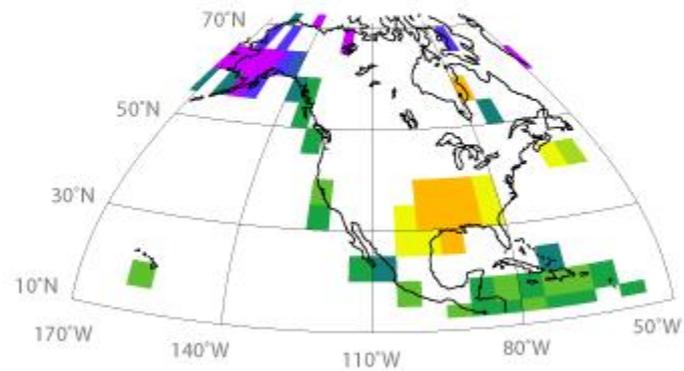
non-OLR La Niña



data: CRU Temp

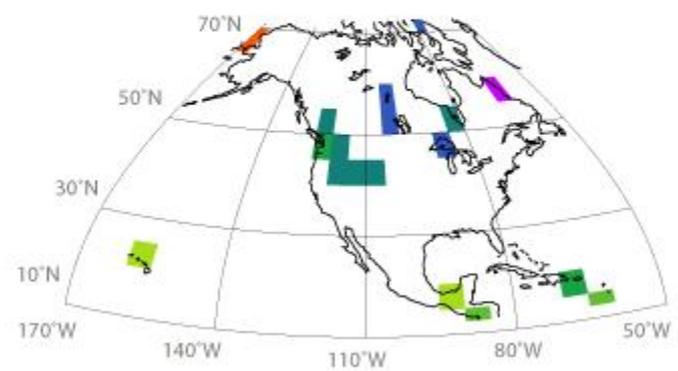
DJF Temperature Anomalies

OLR La Niña



masking at 80% local statistical significance
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non-OLR La Niña

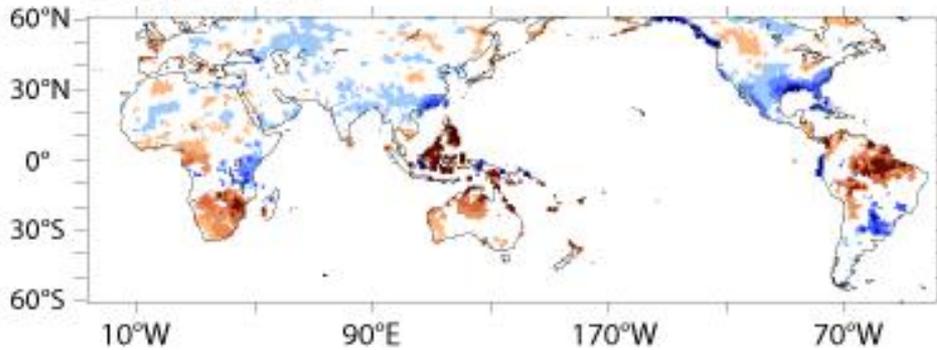


data: CRU Temp

El Niño Seasonal Precipitation Anom.

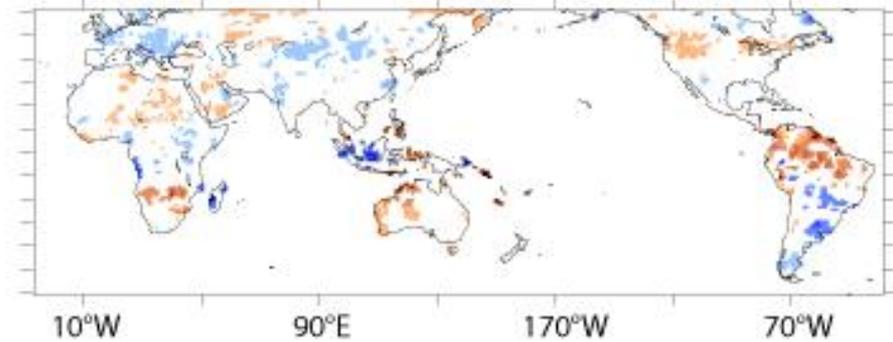
OLR El Niño events

DJF Year 0/1



non-OLR El Niño events

DJF Year 0/1

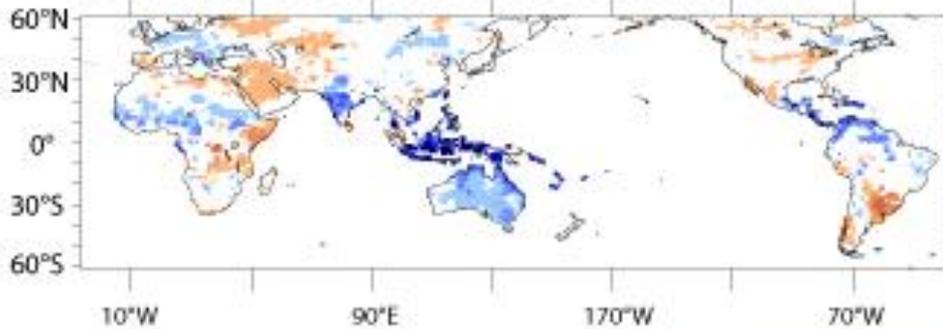


La Nina Seasonal Precipitation Anom.

OLR La Niña events

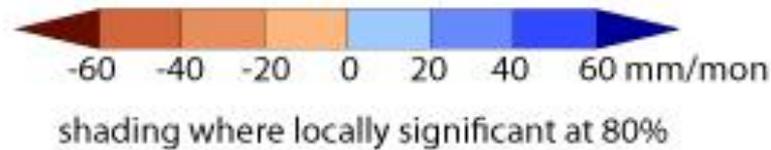
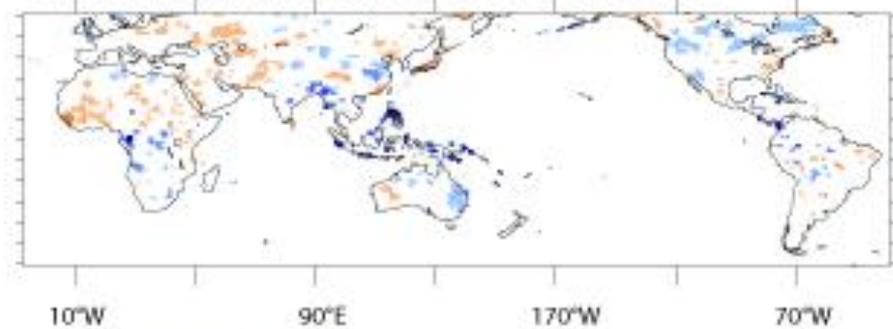
SON Year 0

1974-75, 1975-76, 1988-89, 1998-99, 1999-2000, 2010-11



non-OLR La Niña events

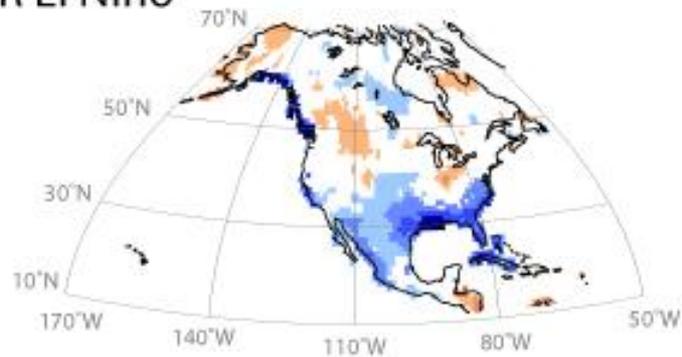
1983-84, 1984-85, 1995-96, 2000-01, 2005-06, 2007-08



Same as before, except masked at the 80% confidence interval,

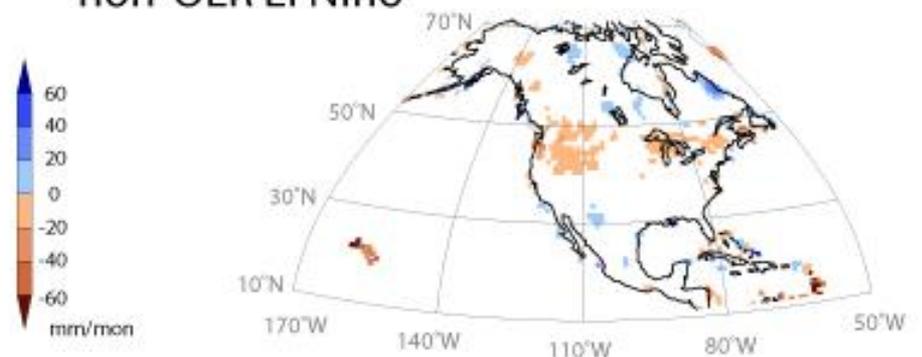
DJF Precipitation Anomalies

OLR El Niño



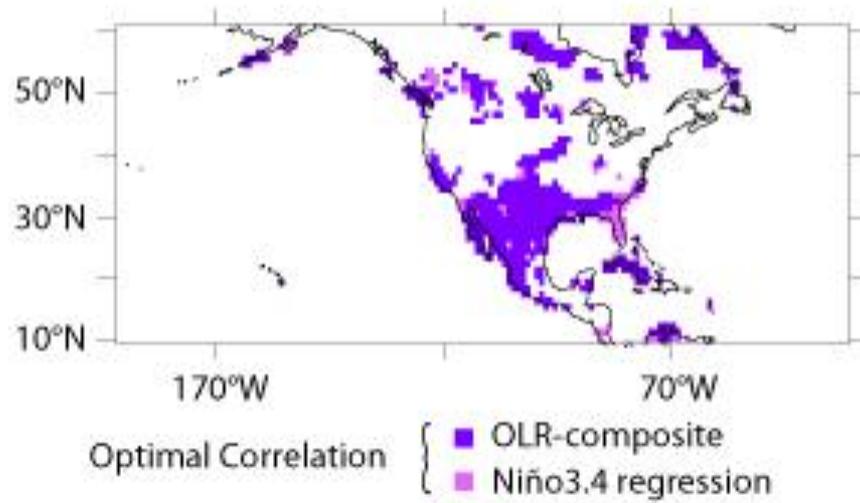
masking at 80% statistical significance
period 1974-2011

non-OLR El Niño

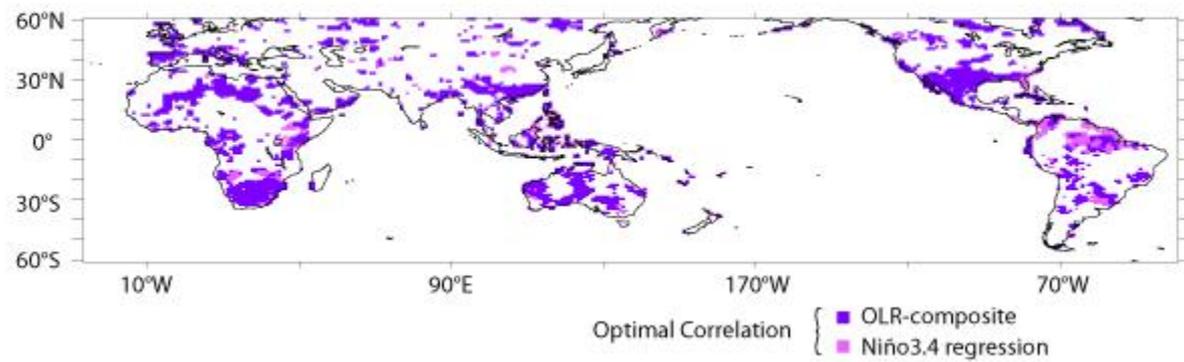


60
40
20
0
-20
-40
-60
mm/mon

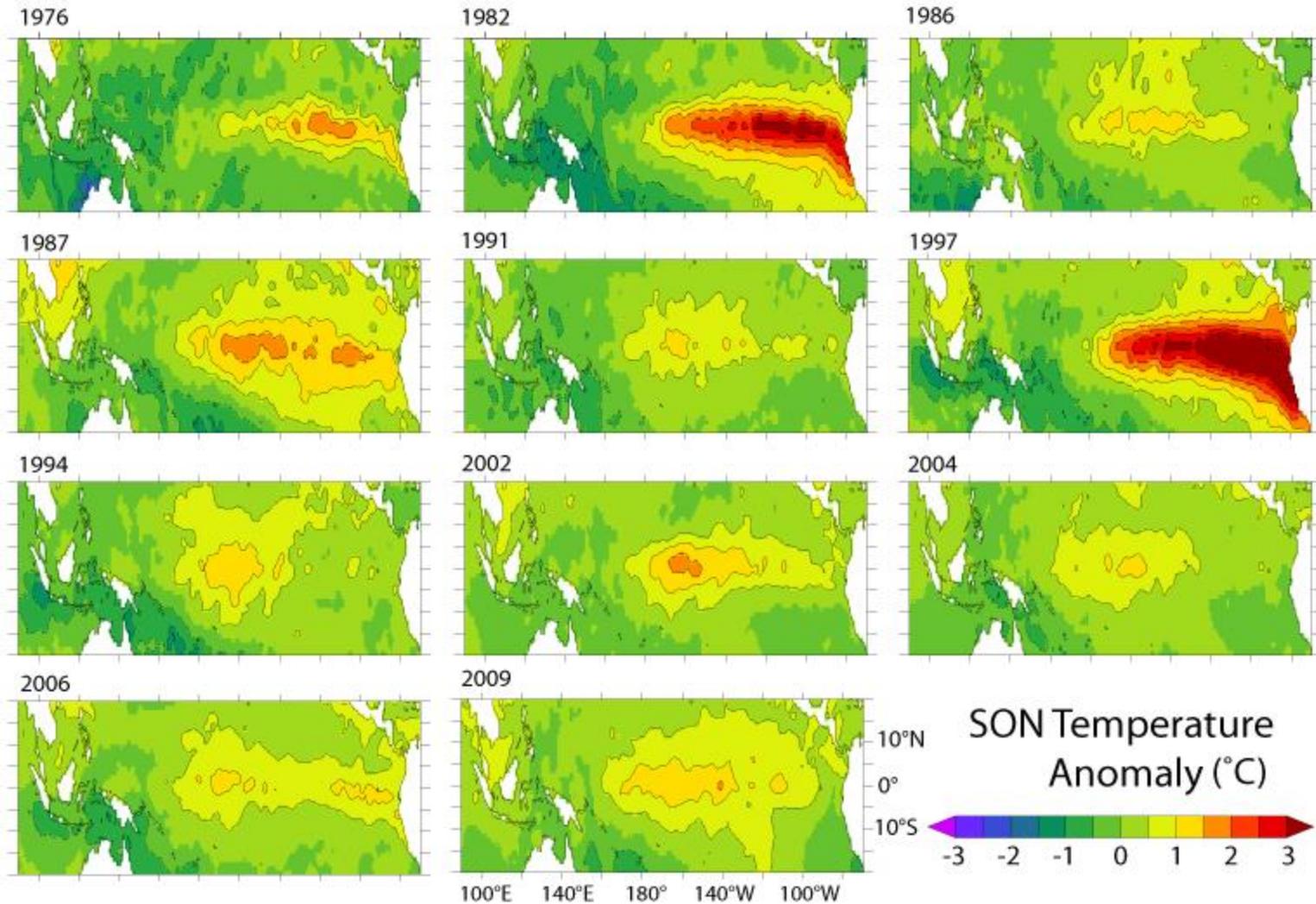
DJF Precipitation Anomaly Hindcast



DJF Precipitation Anomaly Hindcast



El Nino Seasonal SSTA patterns



El Nino Seasonal SSTA patterns

